

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

IN THE CLAIMS:

Please cancel and add claims as follows:

Claims 1-10 (Canceled).

11. (New) A method for preventing seismic liquefaction of ground in a built-up urban area where a loose fine-grained layer vulnerable to seismic liquefaction is underlain with a soft cohesive layer liable to uneven settlement caused by lowering of a groundwater table, with a deep granular layer underlying said soft cohesive layer, said method comprising the steps of:

pumping pore water out of said loose fine-grained layer to lower the groundwater table and thereby create pore voids in said loose fine-grained layer;

pressurizing and pushing said pumped pore water down through said soft cohesive layer into said deep granular layer, an uplift force of said pumped pore water counteracting a downward force caused by the lowering of the groundwater table in said loose fine-grained layer;

blending tap water saturated with dissolved air, micro particles of mineral powder and a diffusing agent in a regulating tube as a tap water mixture;

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

injecting said tap water mixture into said pore voids in said loose fine-grained layer until said pore voids are filled; and

forming, following completion of the foregoing step of injecting said tap water mixture, an air-mixed zone in which a plurality of air bubbles make cores of the micro particles of said mineral powder and are thereby bubbled out of said mixture such that a degree of pore water saturation in said loose fine-grained layer is reduced to prevent seismic liquefaction due to earthquake.

12. (New) The method as set forth in claim 11, wherein said method includes boring a plurality of wells at spaced intervals along each side of a street, each of said wells extending into said deep granular layer.

13. (New) The method as set forth in claim 12, wherein said step of boring said plurality of wells includes forming, for each well, a top well extending through the loose fine-grained layer into a top portion of said soft cohesive layer, a middle well extending from a bottom of said top well to a bottom portion of said soft cohesive layer, and a bottom well extending down from a bottom end of said middle well into said deep granular layer.

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

14. (New) The method as set forth in claim 13, wherein said step of forming said top well, said middle well and said bottom well includes filling said top well and said bottom well with a permeable material, and filling said middle well with an impermeable material.

15. (New) The method as set forth in claim 11, wherein said step of pressurizing and pushing said pumped pore water down through said soft cohesive layer into said deep granular layer is performed while reciprocally injecting compressed air into said deep granular layer to open pore voids clogged by accumulated dusty particles drawn out with the pore water being pumped out of said loose fine-grained layer.

16. (New) A method for preventing seismic liquefaction of ground in a built-up urban area where a loose fine-grained layer vulnerable to seismic liquefaction is underlain with a soft cohesive layer liable to uneven settlement caused by lowering of a groundwater table, with a deep granular layer underlying said soft cohesive layer, said method comprising the steps of:

pumping pore water out of said loose fine-grained layer to lower the groundwater table from an initial groundwater level to

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

a bottom level of said loose fine-grained layer and thereby create pore voids in said loose fine-grained layer;

pressurizing and pushing said pumped pore water down through said soft cohesive layer into said deep granular layer while injecting compressed air into said deep granular layer at a pressure greater than a groundwater pressure at a bottom level of said soft cohesive layer, an uplift force of said compressed air and said pumped pore water counteracting a downward force caused by the lowering of the groundwater table in said loose fine-grained layer;

blending tap water saturated with dissolved air, micro particles of mineral powder and a diffusing agent in a regulating tube as a tap water mixture;

injecting said tap water mixture through a supply valve into said pore voids in said loose fine-grained layer until said pore voids are filled; and

closing said supply valve to make a head level of said tap water mixture fall down to the initial groundwater level, a plurality of air bubbles dissolved in said mixture making cores of said micro particles of said mineral powder and thereby bubbling out of said mixture to reduce a degree of pore water saturation in

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

said loose fine-grained layer to prevent seismic liquefaction due to earthquake.

17. (New) The method as set forth in claim 16, wherein said method includes boring a plurality of wells at spaced intervals along each side of a street, each of said wells extending into said deep granular layer.

18. (New) The method as set forth in claim 17, wherein said step of boring said plurality of wells includes forming, for each well, a top well extending through the loose fine-grained layer into a top portion of said soft cohesive layer, a middle well extending from a bottom of said top well to a bottom portion of said soft cohesive layer, and a bottom well extending down from a bottom end of said middle well into said deep granular layer.

19. (New) The method as set forth in claim 18, wherein said step of forming said top well, said middle well and said bottom well includes filling said top well and said bottom well with a permeable material, and filling said middle well with an impermeable material.

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

20. (New) The method as set forth in claim 19, wherein said permeable material is crushed stone and said impermeable material is bentonite paste.

21. (New) The method as set forth in claim 18, wherein said steps of forming said top well, said middle well and said bottom well includes boring said middle and bottom wells to have a diameter half a diameter of said top well.

22. (New) The method as set forth in claim 18, wherein said step of pressurizing and pushing said pumped pore water to flow down through said soft cohesive layer into said deep granular layer while injecting compressed air into said deep granular layer includes injecting said compressed air reciprocally with said pore water flow to open pore voids clogged by accumulated dusty particles drawn out with the pore water being pumped out of said loose fine-grained layer.

23. (New) The method as set forth in claim 22, wherein said reciprocal injection of compressed air and pumped pore water is controlled using a pressure sensor to detect clogging and a flow

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

rate meter to detect pore water flow rate in excess of a predetermined rate.

24. (New) The method as set forth in claim 17, wherein said step of pressurizing and pushing said pumped pore water to flow down through said soft cohesive layer into said deep granular layer while injecting compressed air into said deep granular layer includes:

providing an air compressor at ground level connected to an airtight tank by an air pipe having an air check valve for holding a reverse flow of overly compressed air, said air-tight tank being connected by a main water pipe to submerged pumps in a bottom of said wells;

providing a reverse flow main pipe extending from said air-tight tank to a bottom of said wells with a water main valve inserted therebetween;

operating said submerged pumps to pump out groundwater into said air-tight tank which pressurizes the groundwater for pumping into said deep granular layer through said reverse flow main pipe with said water main valve open;

suspending the flow of pressurized water into said deep granular layer by closing said water main valve in said reverse

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

flow main pipe upon detection in said main water pipe of a rise in pressure in excess of a predetermined level indicating a clog;

operating the air compressor to force compressed air into said deep granular layer to remove the clog; and

resuming operation of said submerged pumps to pump pressurized water into said deep granular layer upon detection of a pressure level indicating the clog has been removed.

25. (New) A system for preventing seismic liquefaction of ground in a built-up urban area where a loose fine-grained layer vulnerable to seismic liquefaction is underlain with a soft cohesive layer liable to uneven settlement caused by lowering of a groundwater table, with a deep granular layer underlying said soft cohesive layer, said system comprising:

a plurality of vertically-extending wells, with pumps submerged therein, at spaced intervals along each side of a street, each of said wells including a top well extending through the loose fine-grained layer, and a bottom well extending down into said deep granular layer;

a main water pipe and a reverse flow main pipe placed along each side of said street and running generally horizontally, said pipes in communication with said wells;

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

an air-tight tank with an associated air compressor coupled to said pipes;

said submerged pumps pumping pore water out of said loose fine-grained layer into said air-tight tank to lower the groundwater table from an initial groundwater level to a bottom level of said loose fine-grained layer and thereby creating pore voids in said loose fine-grained layer;

said air-tight tank pressurizing said pore water using said air compressor to push pressurized pore water through said reverse-flow main pipe into said deep granular layer while reciprocally injecting compressed air into said deep granular layer to remove clogging, an uplift force of said compressed air and said pumped pore water counteracting a downward force caused by the lowering of the groundwater table in said loose fine-grained layer;

a regulating receptacle for blending tap water saturated with dissolved air, micro particles of mineral powder and a diffusing agent into a tap water mixture, said regulating receptacle being coupled to said pipes after said groundwater table has been lowered to said bottom level of said loose fine-grained layer, said tap water mixture being injected through a supply valve into said pore voids in said loose fine-grained layer until said pore voids are filled; and

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

said supply valve being closed after said pore voids are filled, said closure causing a head level of said tap water mixture to fall down to the initial groundwater level, at least a portion of the air dissolved in said mixture making cores of said micro particles of said mineral powder and thereby bubbling out of said mixture to reduce a degree of pore water saturation in said loose fine-grained layer to prevent seismic liquefaction due to earthquake.

26. (New) The system as set forth in claim 25, wherein each of said plurality of wells further includes a middle well extending from a bottom of said top well to a bottom portion of said soft cohesive layer, said bottom well extending down from a bottom end of said middle well into said deep granular layer.

27. (New) The system as set forth in claim 26, wherein said top well and said bottom well are filled with a permeable material, and said middle well is filled with an impermeable material.

28. (New) The system as set forth in claim 27, wherein said permeable material is crushed stone and said impermeable material is bentonite paste.

Serial No.: 10/661,576
Atty. Docket No.: P69053US0

29. (New) The system as set forth in claim 26, wherein said middle and bottom wells have a diameter half a diameter of said top well.

30. (New) The system as set forth in claim 25, further comprising a longitudinal perforated pipe stretching along an outside boundary of said street at a depth close to a top level of said soft cohesive layer for blowing out air to form a generally impermeable micro air bubble barrier.